

EFFECT OF DIFFERENT LEVELS OF FLY ASH AND VERMICOMPOST ON GROWTH OF LEMONGRASS (*CYMBOPOGON FLEXUOSUS* NEES)

SRINIVAS. P¹, VIJAYA PADMA. S. S², PANDU SASTRY. K³ & SUNITHA DEVI. K. B⁴

^{1,2}Department of Plantation Spices, Medicinal and Aromatic Crops COH, Rajendranagar, Dr. Y. S. R. H. U, India

³CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Research Centre, Boduppal

⁴Department of Agronomy College of Agriculture, Rajendranagar ANGRAU, Rajendranagar, India

ABSTRACT

This investigation was undertaken to study the effect of different levels of fly ash and vermicompost on growth of lemongrass (*Cymbopogon flexuosus* Nees) during the year 2014-2015, at Central Institute of Medicinal and Aromatic Plants (CIMAP), Boduppal, Hyderabad. The results enunciated that among the treatments, T₇ (FA 6 t/ha + VC 4t /ha) recorded significantly maximum plant height (154.6 cm and 123.7 cm), number of tillers (42 and 54), number of leaves (142 and 182), leaf area (207.4 cm² and 159.4cm²) at 90 (First season) and 180 (Second season) days, respectively. The results from the experiment demonstrated that among the different treatments, the treatment T₇ with fly ash 6 t/ha and vermicompost 4 t/ha may be considered as the best treatment obtaining higher plant growth of lemongrass.

KEYWORDS: FA (Fly Ash) & VC (Vermicompost)

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INTRODUCTION

Lemongrass (*Cymbopogon flexuosus* Nees), is a perennial multi cut aromatic grass belonging to the family Poaceae. Its oil is in great demand in the country and is also exported in large quantity. Lemongrass is grown in the states of Kerala, Karnataka, U.P and Assam. The oil is a good source of control and is used in perfumery industry, cosmetics, synthesis of Vitamin A, flavouring herbal teas and other non-alcoholic beverages, confectioneries, scenting of soaps, detergents and insect repellent preparations. The oil also has germicidal, medicinal and flavouring properties.

Lemongrass is known to be a very hardy plant, which can grow in soil types ranging from rich loam to poor laterite, but with a preference to well drained and nutrient rich soils. The plant is also known for its tolerance to soil salinity and alkalinity to a higher level than other crops. The annual world production of lemongrass oil is around 1000 tonnes. In some far Eastern countries like Java, Japan, China and India the leaves are used for flavoring foods, drinks and tea and for scenting bathwater.

Lemon grass is generally recognized as safe for human consumption as plant extract/essential oil. In the case of aromatic plants such as lemon grass, the quality and the quantity of essential oil are important aspects. Organic farming is gaining momentum especially in the cultivation of medicinal and aromatic plants owing to reputed improvements in the quality of the produce, under organic systems of farming as well as the price premiums for certified produce. Fly ash is a by-product of pulverized coal fired thermal power stations. Fly ash contains several essential nutrients like K, P, Ca, Mg, S, B, Fe, Cu, Zn, Mn and Mo which are beneficial for plant growth. Fly ash improves the fertility status of soil, structure, texture and physical properties and improves crop

yield. It optimizes pH value, improves soil aeration and reduces crusting formation. The research done so far in agricultural and horticultural crops indicates that the fly ash could be a better option to replace the chemical fertilizers in developing countries. The best alternative of the present day's environmental degradation is to make proper use of the available unutilized organic biodegradable wastes in order to convert them into compost within a short period.

Vermicompost is found to effectively enhance the root formation, elongation of stems and production of biomass in agricultural and horticultural plants. Vermicompost has higher levels of available nutrients like nitrate or ammonium nitrogen, exchangeable phosphorous and soluble potassium, calcium derived from the wastes. Vermicompost stimulates the growth of a wide range of plant species of different horticultural crops due to several direct and indirect beneficial effects as in pepper. Arancon *et al.*, (2005). Vermicompost has also been found to have positive effects for some aromatic and medicinal plants Anwar *et al.*, (2005). It exerts a positive effect on vegetative growth, stimulating shoot and root development. Edwards *et al.*, (2004). Hence, the experiment was conducted with the object to find out the combine effect of fly ash and verimicompost on the growth of lemongrass.

MATERIAL AND METHODS

The variety selected for the present experiment was Krishna, which was released by CIMAP, Lucknow for cultivation in South India. The experiment was laid out in Randomized Block Design with twelve treatments replicated thrice. Gross Plot size: 3.9×3.9 m and net plot size of: 3.6×3.6 m. A spacing of 60 cm between the rows and 60 cm between the plants and within the rows was adopted for all the treatments.

The treatments included $T_1 : (F_0 + V_{10})$ Fly ash(0 t/ha) + Vermicompost (10 t/ha), $T_2 : (F_1 + V_9)$ Fly ash (1 t/ha) + Vermicompost (9 t/ha), $T_3 : (F_2 + V_8)$ Fly ash (2 t/ha) + Vermicompost (8 t/ha), $T_4 : (F_3 + V_7)$ Fly ash (3 t/ha) + Vermicompost (7 t/ha), $T_5 : (F_4 + V_6)$ Fly ash (4 t/ha) + Vermicompost (6 t/ha), $T_6 : (F_5 + V_5)$ Fly ash (5 t/ha) + Vermicompost (5 t/ha), $T_7 : (F_6 + V_4)$ Fly ash (6 t/ha) + Vermicompost (4 t/ha), $T_8 : (F_7 + V_3)$ Fly ash (7 t/ha) + Vermicompost (3 t/ha), $T_9 : (F_8 + V_2)$ Fly ash (8 t/ha) + Vermicompost (2 t/ha), $T_{10} : (F_9 + V_1)$ Fly ash (9 t/ha) + Vermicompost (1 t/ha), $T_{11} : (F_{10} + V_0)$ Fly ash (10 t/ha) + Vermicompost (0 t/ha), $T_{12} :$ Normal dose of chemical fertilizer (100:40:40 kg/ha), $T_{13} :$ Zero fertilizer (control).

Treatments were imposed on the standing crop after first harvest. The experimental area was kept weed free. Weeding was done at 30 days interval. The first irrigation was given immediately after planting. The subsequent irrigations were given as and when required depending upon soil moisture and weather conditions. Twenty five irrigations were given to the crop in 6 months duration. Lemongrass is a multi harvest perennial crop. The first harvest of the crop is taken 90 days and second harvest was taken at 180 days.

Plant height, number of tillers, number of leaves and leaf area were measured from 15 randomly tagged plants in each treatment at five plants from each replication at every 15 days interval after planting the slips and their mean values were calculated.

RESULTS AND DISCUSSIONS

Effect of different Doses of Fly Ash and Vermicompost on Plant Height

Maximum plant height was recorded in T_7 in both the seasons and plant height increased with increasing level of fly ash from 0 t to 6 t/ha and decreasing level of vermicompost from 10 to 4 t/ha (T_1 - T_7). The increase in plant height might be due to the balanced supply of nutrients to the plants with these combinations.

Table 1

Treatments (T)	Number of Leaves											
	First Crop						Second Crop					
	15 Days	30 Days	45 Days	60 Days	75 Days	90 Days	105 Days	120 Days	135 Days	150 Days	165 Days	180 Days
T ₁ : (FA 0 t+ VC 10 t)	83.7	91.4	103.6	110.5	112.6	118.6	60.5	73.5	75.4	88.3	88.3	93.2
T ₂ : (FA 1 t+ VC 9 t)	89.2	94.3	114.8	115.4	119.4	125.3	63.3	77.2	79.5	92.4	91.4	98.2
T ₃ : (FA 2 t+ VC 8 t)	93.1	101.4	119.6	121.1	125.6	132.4	65.2	80.3	83.5	94.9	94.2	105.6
T ₄ : (FA 3 t+ VC 7 t)	95.9	107.4	121.3	126.5	129.7	139.4	67.3	84.5	88.3	101.2	102.5	112.5
T ₅ : (FA 4 t+ VC 6 t)	97.7	115.8	127.7	131.3	136	143.7	71.4	90.5	94.5	107.5	107.5	119.6
T ₆ : (FA 5 t+ VC 5 t)	106.3	121.3	136.6	143.3	145.5	149.4	75.7	94.5	105.5	114.3	114.4	122.4
T ₇ : (FA 6 t+ VC 4 t)	106.9	122.6	137.9	144.5	146.4	154.6	71.7	95.3	106.6	115.5	115.5	123.7
T ₈ : (FA 7 t+ VC 3 t)	105.9	121.5	136.8	144.2	145.8	153.9	70.6	93.8	104.8	113.8	113.6	121.7
T ₉ : (FA 8 t+ VC 2 t)	106.2	120.8	137.3	143.9	144.7	154.2	71.5	94.5	106.2	114.5	115.1	122.7
T ₁₀ : (FA 9 t+ VC 1 t)	105.7	122.2	135.9	144.1	145.2	153.1	70.5	95.1	105.7	114.2	114.4	120.2
T ₁₁ : (FA 10 t+ VC 0 t)	105.2	121.3	135.7	143.1	144.3	152.7	69.9	94.4	105.2	115.1	114.6	121.8
T ₁₂ : (FA 0 t+ VC 10 t)	79.3	92.3	101.6	110	111.5	117.3	59.1	72.4	74.2	87.4	87.4	92.4
T ₁₃ : (FA 0 t+ VC 10 t)	71.4	75.8	81.6	84.5	85.2	86	47.9	61.3	61.4	68.1	72.3	85.4
SEm±	0.994	1.171	1.003	0.937	0.866	1.170	1.16	1.06	1.169	1.100	1.021	1.420
CD (0.05)	2.919	3.439	2.944	2.750	2.543	3.436	3.41	3.13	3.431	3.229	2.998	4.16

In second crop, the plant height decreased due to low temperatures during the period of December to January. In the second crop also significant increasing trend in plant height was observed with higher concentration of fly ash.

These results were in conformity with Katiyar *et al.*, (2012) who reported that increased plant height in Palak, mung bean and chili on fly ash application. Adequate availability of micronutrients might have helped in increasing plant height. Prakash *et al.*, (2014). The fly ash when applied in combination with vermicompost and NPK had improved the crop growth of wheat Yavarzadeh and Shamsadini, (2012). Khan and Khan (1996) found that tomato plants responded positively to FA soil amendment showing luxuriant growth up to 60% or 70%. A significant increase in plant height with 5-10 t/ha of fly ash was reported by Kuchanwar *et al.*, (1997).

Ajaz and Tiyaagi (2003) reported improved plant growth characters in cucumber in fly ash amended soil. The lettuce seedlings showed greatest shoot length at 10 % fly ash Srivastava *et al.*, (1995).

Application of vermicompost (4 t/ha) resulted in a significant increase of plant height Choudhary *et al.*, (2014). Sekar, *et al.*, (2013) observed that treatment with 5 t/ha of vermicompost showed significantly higher growth in Chile while increased plant height in dragon head was reported with 4 t/ha vermicompost Mafakheri *et al.*, (2013).

Number of Tillers

The results indicated that there is a significant increase in the number of tillers with higher concentrations of fly ash. The treatment T₇ (FA 6 t/ha + VC 4 t/ha) was significantly superior to all other treatments in both crops.

Table 2

Treatments (T)	Number of Tillers											
	First Crop						Second Crop					
	15 Days	30 Days	45 Days	60 Days	75 Days	90 Days	105 Days	120 Days	135 Days	150 Days	165 Days	180 Days
T ₁ : (FA 0 t+ VC 10 t)	31	32	36	38	39	39	26	26	27	28	29	32
T ₂ : (FA 1 t+ VC 9 t)	33	34	39	41	41	42	27	28	29	30	31	35
T ₃ : (FA 2 t+ VC 8 t)	36	36	40	42	43	44	28	29	31	32	32	37
T ₄ : (FA 3 t+ VC 7 t)	37	38	43	44	45	46	28	31	32	35	35	39
T ₅ : (FA 4 t+ VC 6 t)	40	41	47	47	48	49	30	33	33	35	37	40
T ₆ : (FA 5 t+ VC 5 t)	42	43	46	48	50	53	31	34	35	37	37	41
T ₇ : (FA 6 t+ VC 4 t)	43	44	47	49	52	54	32	34	35	37	39	42
T ₈ : (FA 7 t+ VC 3 t)	41	43	45	47	49	52	32	32	34	36	37	41
T ₉ : (FA 8 t+ VC 2 t)	42	44	46	48	51	55	32	34	34	37	38	41

Table 2: Contd.,

T ₁₀ : (FA 9 t + VC 1 t)	41	43	47	47	50	52	31	33	35	36	37	39
T ₁₁ : (FA 10 t + VC 0 t)	41	44	46	48	50	53	32	33	35	36	37	40
T ₁₂ : (FA 0 t + VC 10 t)	32	32	35	38	38	40	24	25	26	29	29	32
T ₁₃ : (FA 0 t + VC 10 t)	23	26	26	27	28	29	16	17	19	20	21	24
SEm±	0.828	1.060	0.973	1.045	1.025	1.044	0.95	0.86	1.034	0.848	1.107	1.083
CD (0.05)	2.431	3.113	2.858	3.067	3.011	3.066	2.81	2.52	3.036	2.490	3.251	3.175

The highest number of tillers might be due to the fact that adequate amounts of fly ash and vermicompost combination provided major plant nutrients to the plant growth and biomass accumulation. The number of tillers was decreased due to low temperatures during the period of December to January.

The results were in agreement with the Mukherjee *et al.*, (2002) who reported a significantly higher number of tillers in Palmarosa when treated with fly ash mixed with coir pith. The fly ash when applied with in combination with vermicompost and NPK had improved the crop growth of wheat. Yavarzadeh and Shamsadini, (2012).

Application of vermicompost (4 t/ha) resulted in a significant increase of the number of tillers Choudhary *et al.*, (2014). Vermicompost improves the growth of many agricultural crops Arancon *et al.*, (2004). Diwakar *et al.* (2014) found that 75% N + 2 t vermicompost in integrated mode gave highest values of growth in basmati rice.

Number of Leaves

Similar to the number of tillers the maximum number of leaves (182) was observed in the treatment T₇ in both the crops. In a second crop, number of leaves decreased due to low temperatures during the period of December to January. In both the crops also significant increasing trend in the number of leaves was observed with higher concentration of fly ash.

Table 3

Treatments (T)	Number of Leaves											
	First Crop						Second Crop					
	15 Days	30 Days	45 Days	60 Days	75 Days	90 Days	105 Days	120 Days	135 Days	150 Days	165 Days	180 Days
T ₁ : (FA 0 t + VC 10 t)	76	89	113	123	133	136	56	68	85	96	105	106
T ₂ : (FA 1 t + VC 9 t)	81	97	115	127	139	142	59	71	87	102	115	116
T ₃ : (FA 2 t + VC 8 t)	84	102	116	135	149	155	62	73	89	109	121	123
T ₄ : (FA 3 t + VC 7 t)	88	104	122	142	153	164	66	77	103	116	126	127
T ₅ : (FA 4 t + VC 6 t)	93	106	131	153	160	173	71	84	108	121	134	136
T ₆ : (FA 5 t + VC 5 t)	100	114	146	164	176	180	76	89	114	129	140	140
T ₇ : (FA 6 t + VC 4 t)	101	116	147	165	176	182	76	91	115	130	140	142
T ₈ : (FA 7 t + VC 3 t)	101	115	147	164	175	181	76	89	114	129	139	140
T ₉ : (FA 8 t + VC 2 t)	101	115	147	165	174	180	75	90	114	128	138	141
T ₁₀ : (FA 9 t + VC 1 t)	100	114	145	165	175	181	76	89	113	129	138	140
T ₁₁ : (FA 10 t + VC 0 t)	100	114	147	164	174	180	75	89	114	128	138	139
T ₁₂ : (FA 0 t + VC 10 t)	75	87	112	123	130	135	56	66	86	97	105	106
T ₁₃ : (FA 0 t + VC 10 t)	45	61	81	90	105	104	38	54	63	53	45	83
SEm±	0.964	1.158	1.108	1.077	1.189	1.145	1.091	1.082	1.115	1.030	1.479	1.341
CD (0.05)	2.831	3.399	3.254	3.163	3.491	3.362	3.20	3.17	3.273	3.024	4.344	3.939

Maximum number of leaves in treatment T₇ that received 6 t/ha fly ash and 4 t/ha vermicompost, was may be due to improvement in water holding capacity and balanced supply of micro and macro nutrients, which is beneficial for the plant growth.

The results are in conformity with the findings of Pandey *et al.* (1994). They reported an increase in the number of leaves in sunflower grown in fly ash amended soil when compared to respective unamended control. Number of leaves increased when lettuce seedlings were transferred to pots filled with fly ash and soil mixtures. Srivastava *et al.*, (1995). Fly ash application (25%) increased the number of leaves in Palak, mungbean and chili. Katiyar *et al.*, (2012). The application of 60% fly ash and *Sclerocystis sinuosa* resulted in the greatest number of leaves. Patil, (2013).

A significant increase in growth and related parameters in *Vigna radiata* and *Centella asiatica* was observed by Nirmala *et al.* (2009). Sekar, *et al.* (2013) observed that treatment with 5 t/ha of vermicompost showed significantly higher growth in chilli. Diwakar *et al.* (2014) found that 75% N + 2 t vermicompost in integrated mode gave highest values of growth in basmati rice. The number of leaves per plant was maximum in cabbage with 5 t/ha of vermicompost Kumar *et al.*, (2008).

Leaf Area

The maximum leaf area (207.4) was observed in the treatment T₇ in both the crops. In the second crop, leaf area was decreased due to low temperatures during the period of December to January as per the Annexure-1. In both the crops significant increasing trend in the leaf area was observed with higher concentration of fly ash. The leaf area increased with the increase in fly ash up to treatment T₇.

A maximum leaf area in treatment T₇ may be due to improvement in water holding capacity and balanced supply of micro and macro nutrients which is beneficial for the plant growth.

Table 4

Treatments (T)	Leaf Area											
	First Crop						Second Crop					
	15 Days	30 Days	45 Days	60 Days	75 Days	90 Days	105 Days	120 Days	135 Days	150 Days	165 Days	180 Days
T ₁ : (FA 0 t + VC 10 t)	58.4	87.3	96.4	104.5	121	153.5	40.3	66.2	72.4	83.5	93.7	118.4
T ₂ : (FA 1 t + VC 9 t)	65.7	92.5	105.7	119.7	129.2	165.4	43.4	71.4	75.6	89.5	105.4	126.5
T ₃ : (FA 2 t + VC 8 t)	67.5	96.1	107.5	125.6	138.5	173.5	46.3	76.6	79.2	96.5	109.6	134.3
T ₄ : (FA 3 t + VC 7 t)	70.4	99.4	109.2	131.6	146.2	181.5	48.3	79.5	87.3	102.4	114.4	141.3
T ₅ : (FA 4 t + VC 6 t)	72.6	102.6	121	138	149.4	190.4	51.3	86.3	89.5	109.5	119.2	148.3
T ₆ : (FA 5 t + VC 5 t)	74.8	113.5	127.2	141.5	159.3	206.2	55.5	89.5	92.4	112.5	124.5	158.2
T ₇ : (FA 6 t + VC 4 t)	75.5	114.4	127.8	142.6	160.5	207.4	56.3	90.2	93.3	112.6	125.4	159.4
T ₈ : (FA 7 t + VC 3 t)	74.6	113.8	126.7	141.5	159.6	206.7	55.7	89.4	92.4	110.8	124.3	158.2
T ₉ : (FA 8 t + VC 2 t)	73.9	114.1	125.9	142.1	160.1	207.1	54.8	88.8	91.8	111.7	123.8	157.8
T ₁₀ : (FA 9 t + VC 1 t)	75.1	113.2	127.3	140.9	158.7	205.9	56.1	89.7	91.1	112.2	125.1	159.1
T ₁₁ : (FA 10 t + VC 0 t)	74.8	112.8	126.2	141.7	159.1	206.1	55.1	88.2	92.8	110.8	124.8	158.8
T ₁₂ : (FA 0 t + VC 10 t)	57.3	86.5	94.2	105.6	120.4	155.2	40.6	67.2	73.5	84.6	94.2	119.4
T ₁₃ : (FA 0 t + VC 10 t)	43.7	70.1	66.6	74.4	99.7	120.5	29.6	55.5	63.4	69.6	73.3	85.4
SEm±	0.923	0.978	0.994	1.076	1.019	1.123	1.05	1.24	1.174	1.420	1.344	1.248
CD (0.05)	2.709	2.871	2.918	3.160	2.993	3.297	3.10	3.66	3.448	4.169	3.947	3.663

The results are in conformity with the findings of Mishra *et al.* (2007) and Pandey *et al.* (1994) who reported similar results in rice. Significant improvement in leaf area of cucumber was observed at 10, 25 and 50% fly ash treatment Ajaz and Tiyaqi, (2003). Patil (2013) observed maximum leaf area in garlic when treated with 60% fly ash and *Scerocystis* *sense*. 10% fly ash gave greater leaf area in lettuce seedlings. Srivastava *et al.*, (1995). Khan and Khan (1996) reported bigger and greener leaves in tomato plants when grown in an ash - soil mixture.

A significant increase in growth and related parameters in *Vigna radiata* and *Centella asiatica* was observed by Nirmala *et al.* (2009). Vermicompost 5 t/ha + 50% recommended fertilizer gave significantly better growth Munnu Singh, (2011). Sekar, *et al.* (2013) observed that treatment with 5 t/ha of vermicompost showed significantly higher growth in chilli. Man and Wang (2014) reported an increase in leaf area of muskmelon by using substrate with a mixture of vermicompost, rice hulls and coconut husk (1:1:1).

CONCLUSIONS

As the organic farming is gaining momentum for growing of crops, this study will be helpful to grow the lemongrass by using the combination of fly ash and vermicompost in an efficient way. In this experiment, the observations were recorded on plant growth characters like plant height, number of tillers, number of leaves, leaf area, and it is concluded that Treatment 7 which received 6 t/ha of fly ash and 4 t/ha of vermicompost recorded significantly maximum plant height at first (154.6cm) and second harvest (123.7cm). So, the 6t of fly ash and 4t of vermicompost is recommended dose for good growth of the lemongrass.

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